## A Review on Phytoremediation A Sustainable Solution for Treatment of Kitchen Wastewater

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Abstract: Water contamination is a major problem world is facing today and the kitchen waste is one of the important factors. The kitchen waste water contamination consists of mainly micro-organisms, toxic organic and inorganic matter. It is found that phytoremediation is one of the effective methods for the removal of pollutants from water and soil. Phytoremediation consist of media beds, plants, micro-organisms which is mainly depends on physical, chemical and biological activity to remove the contaminants. Phytoremediation reduce the pollutant concentration, such as Biochemical Oxygen Demand, Chemical Oxygen Demand, total dissolved solid, Total Solids solid, Total Phosphorus, Total nitrogen from the kitchen wastewater as plants play a great role in the removal of pollutants. This paper focused on the treatment of kitchen wastewater by phytoremediation.

Keywords: plants, phytoremediation, HRT, kitchen wastewater, pollutants

#### 1. Introduction

Water is most important for the existence of all living forms. It is an easy solvent, enabling most pollutants to dissolve in it easily and contaminate it. Increasing population, urbanisation and industrialisation has led to the deterioration Water pollution is directly suffered by the of water. organisms and vegetation that survive in water, including amphibians. Domestic and industrial waste is the most common cause for water pollution. In domestic waste kitchen is one of the important factors for water pollution. When kitchen waste enters water bodies it dissolves in water and it results in the deterioration of water quality. As Kitchen play an important role in daily life, mainly educational and professional organizations and large quantity of liquid organic waste are generated from kitchen and food services are polluting water bodies. Kitchen wastewater contains Solid food particles; oil and grease stick inside of the pipe which clogs the pipes in the facility. Kitchen waste is a left-over organic matter, washing soap and detergent from restaurants, hotels and households in which restaurants plays major role in discharging kitchen waste in to the environment. In India restaurant industry is growing at a faster rate with wide range of cuisines and the diverse cooking techniques (13).

Kitchen wastewater is the raw sewage contains high organic, suspended solids, oil and grease which cause harm to the environment and human health. Pollutants can also affect the ground waters. When water is contaminated with organic matter the mosquito larvae will survive may increases because organic matter provides food for larvae to eat. Drinking contaminated water can cause serious health problems like diarrheal diseases, Cholera, and other illnesses such as Guinea worm disease, Typhoid, and Dysentery. It is difficult to identify excess nitrogen containing water because of its colourless tasteless property. This type of water may not cause sudden adverse effects but gradually reacts with haemoglobin & reduces the oxygen in the body. Some of the serious illness caused by nitrate that are listed in various studies such as chronic inflammatory, blue-baby cancer, enema of eyelids, tumour, congestion of nasal mucous membranes and pharynx, stuffiness of the head and gastrointestinal, muscular, reproductive, neurological and genetic malfunctions. It is important to control kitchen waste water for the betterment of the society and our future. The wastewater is treated by three methods such as physical, chemical and biological process in the transformation and consumption of organic matter.

Term "phytoremediation" derived from the Greek prefix phyto (plant) and Latin remedium (to correct or remove an evil). It is an eco-friendly biological treatment method suitable for kitchen wastewater treatment. In this method contaminants are removed by macrophytes. Plants absorb the pollutants along withwater andother nutrients. The contaminant mass is not destroyed but ends up in the plant shoot and leaves. It is a natural wastewater treatment method and cost effective. Phytoremediation technology has been widely applied for sewage treatment, pollution control and environmental improvement (20). The removal of extra nutrients and pollutants from wastewater occurs through various processes such asreduction, precipitation, filtration, settling, oxidation, sedimentation, nitrification, adsorption and denitrification. It acts as a biological filter by removing pollutants such as organic materials and nutrients from the wastewater. This domestic waste consists of organic and inorganic waste includes waste oils, food scraps and detergent (13) it is a natural wastewater treatment method and cost effective

#### 2. Plants Role in Phytoremediation

The plants play an important role in purifyingwastewater by removing organic and inorganic contaminants. The aquatic plants are harvestable as well as economic product. The plants provide a large surface area for the better results and growth of micro- organisms. The aquatic plants remove of pollutants and up taking of nutrients and breakdown the organic and in organic matter from wastewater [8]. The capacity of wetland plants uptake for nutrients depend on the species of plants, quality of sewage, the growth rate and depth of roots .The oxygen carrying capacity and water conduction of root zone are related to the development of root system [20]. The plants fit for local condition and fast developed of root system, those have economic values and decontamination efficiency. A dense root system has a high potential to reduce the pollutants by controlling water table.

### 3. Filter Media Role in Phytoremediation

Gravel and soil is the most commonly used growth media in phytoremediation processes. Gravel is an extremely effective filter media, it hold the ability to precipitate the contaminated water. Sand and gravel layer remove the bacteria and other small practical from wastewater. Gravel filters are very effective in removing sediment and heavy metals from contaminated water and less effective in removing dissolved nutrients. Gravels are used for purification of water.

#### 4. Mechanism of Phytoremediation

There are various forms of phytoremediation technology which are applicable in treatment of wastewater. Uptake mechanisms of plant help in remediating organic and inorganic contaminants from wastewater in Phytoremediation method. (Barceló and Poschenrieder2003).

**4.1 Phytoextration-** In this processes plants uptake the contaminants by the root and translocate it to the above parts of the plants by absorbing, concentrating and precipitating the pollutant from contaminated zone.

**4.2 Phytodegradation-** In this metabolic process breakdown the pollutants in the soil. Microorganisms consume nutrients from the organic substances.

**4.3 Phytovolatization-** Plants absorb pollutants from water as well as soil and then release or supply to the atmosphere in the form of vapour at low concentrations through the leaves.

**4.4 Rhizofiltration-** Removal of the pollutants in surface water by precipitation and adsorption using plant roots.

**4.5 Phytostabilization-** Plantsimmobilize orsolidify the pollutants in the water and soil throughaccumulation and absorption in plant.

**4.6 Phytotransformation-** The use of plant to the uptake and transformation of contaminant from soil. The plants release natural enzymes that cause fast chemical reaction to

take place. Break down contaminated by metabolic processes.

**4.7 Hydrolic control-** To control the water table. Dense root large volume of water absorbs and reduces infiltration of precipitation.



Figure 1: Processes of phytoremediation

# 5. The Contaminants Removal Mechanisms in Phytoremediation

Wastewater constituents	Removal Mechanisms					
Suspended solid	<ul><li>Sedimentation</li><li>Filtration</li></ul>					
Soluble organics	• Aerobic and Anaerobic microbial degradation					
Phosphorus	<ul><li>Matrix sorption</li><li>Plant uptake</li></ul>					
Nitrogen	<ul> <li>Nitrification</li> <li>Denitrification</li> <li>Plant uptake</li> <li>Matrix adsorption</li> </ul>					
pathogen	<ul> <li>Sedimentation</li> <li>Filtration</li> <li>Predation</li> <li>UV irradiation</li> <li>Excretion of antibiotics from root of macrophytes</li> </ul>					

## 6. Literature Review

Sr No.	Author	plants	Type of flow	Media	HRT	Result	Remark
1	Namratha,Harshini, Hamsalekha, et. al	Canna	VSSF	Sand and gravel	3 days	COD -90.6% BOD- 87.9%, NH3-N- 66.7% TN- 63.4% TP- 92.6%	Plantation of canna is a good option in wetland development for better efficiency.
2	A.V. Chopra et al.	Typha	HFCW	Sand,soil	-	TDS-15% TN-40% BOD-65%	Pollutant removal efficiency is good in typha plant.

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r	1	1					
			VFCW	,gravel		COD-60%	
3	Sara G. Abdelhakeem,					COD- 75% 29%	Pollutant concentration
	Samir A Aboulroos	Phragmites Australis	VSSE	Gravel	_	BOD- 84% 37%	of each effluent is
1	Samin A. AUUUIIUUS	1 magninesAusualis	4 2 2 1	Graver	-		
						188-75% 42%	directly related to
						NH4- 32% 26%	influent pollutant load.
						TP-22% 17%	_
						planted and upplanted bed	
						pH 60.5%	
	Oladejo, O.					D.O 77.5%	
	Seun, Owoade, Nelson	Pistia				nitrate 66.7% sulphate, 93.3%,	
4	Adeshina	Stratiotes and		Sand		turbidity 80%	In kitchen waste water
	at al	Eichhamia anaginag	VE	ound	10	aclar 42.60/	alsoonun water hussinth
	et. al	Elementaria- crassipes	VГ	anu	10	0101, 45.078	ckeanup water nyacintii
				aggregate	days	chloride 34.6%	is suitable and efficient.
						magnesium 70%	
						pH - 6.73 to 6.76	Nitrogen removal
						turbidity 20NTU to 20NTU	affinianay is good in
	<b>a b</b>						efficiency is good in
	Samson O.					Nitrate-51.9%	Canna plant, fairly
	Ojoawo,GaddaleUdaya					Phosphate –8.9%	effective in Phosphorus
5	kumar	Reed	HSSF	Gravel	3hrs	Phenolic compounds- 1.0 %	removal and very poor
_					-	1 .	in removing Phenolic
							compound.
6	Kavya S Kallimani ,	PhragmitesAustrails	HSSF	Gravel	1-6	pH-6.4-7.6 and 6.7-8.1,	PhragmitesAustrails
	Arjun S Virupakshi2	and		and	days	COD 84% and 76%	plant is more efficient
	5 1	Canna Indica	I. I.	sand		BOD 71% and 67%	than Canna Indica plant
		Califia Indica	1 N .	Sand	h	Total solid 800/ and 810/	in wests water
			N	J	111	Total solid 80% and 81%	in waste water
				7 5		Dissolved and 79% and 75%,	treatment.
				$\langle \rangle$		Suspended 76% and	
						74%PhragmitesAustrails and	
			/			Comes Indias had	
			/	$\langle \rangle$			
7	Xiaoyun Fu ,Xingyuan	Acoruscalamus,	culture		5 days	Total Nitrate	Lower TN and TP in
	He	Lythrumsalicaria,	bucket			A. calamus -97.7%	vegitation
		Monochoriakorsakowii				L salicaria- 94 9%	thanunvegetated
		Alignationtals and				M korsekowij 06.4%	traatmanta
			1			WI. KOISaKOWII -90.476	treatments.
		Sagittaria sagittifolia				A.orientale-91.2%	
						BOD -81.42 %	
8	Anwaruddin Ahmed					COD - 84.57 %	Media and constructed
-	Wurochakkaa	Lenironia Articulata	HSSE	Gravel	3 dave	AN 30.83.%	wetland is suitable for
	Wullocherkea,	LephoniaArticulata	11551		5 uays	AIN- 37.03 /0	
	NurulAzmaHarun			and sand		55- 54.70 %	I reatment of greywater.
		10			1 I	Turbidity- 45.01 %	
	OnanongPhewnil.	Typhaangustifolia Linn	VFCW	Sand	1-71	The BOD, TSS removal	Typha shows higher
9	KasemChunka et al	Cyperuscorymbosus		and	dave	efficiencies of Typha a	biomass and growth
	Rasementarika et ar	Detthe and Cause in dias		Current	uays	Compared and Compared disc	bioinass and growth
		Rollb., and Canna Indica		Gravel		Cyperus, and Canna Indica,	rate.
						were 88.47%, 82.16%, and	
						86.62%, respectively. And	
					/	58.77% 48.47% and 47.91%	
					_	respectively	
10	II	Diama is A is it	HOOP	C 1	20	Dhamana't A t '1 1	
10	HosseinRezaie et al	PharamitesAustrails	HSSF	Sand	20	PharamitesAustrails and	I he typha and read
		and	1111		days	TyphaLotifolia	plants are more efficient
		TyphaLotifolia		1.		Nitrate- 81.4% & 92.6%	in the elimination of
						Phosphate- 84 66% and	nitrate and phosphate
1						74 0 40/	normantiv-1
			TRACE		10.1	/4.2470	respectively.
11	Mega Anggraeni, et. al	Canna Indica and	HSSF	Gravel	12days	Removal rate	As compare with the
		Cyyperus		and Sand		in gravel bed	gravel bed to sand bed
						BOD-0.45	as compare with gravel
						COD 0.26	hed cond had has
						Ammonia-0.49	decrease in removal rate
						Nitrate0.60	of pollutants.
						in sand bed	-
						BOD-0.16	
						COD-0.09	
						Ammonia -0.20	
						Nitrites-0.45	
12	Arivoli A	Typhaaugustifolia		Gravel	12 24	The removal efficiency of	Maximum removal
14	Mohanne: D	1 y phunugustitona	VECW	and	12, 27	planted and upplanted	afficiancias of the
	wonanraj K		VFUW	and	and	planted and unplanted	enterencies of the
				Sand	36	TDS- 84.66% and 67.26%	pollutants in planted
1					hours	Turbidity-92.90% and 64.76%.	system Compare to
1						COD- 80.53% and 64 70 %	unplanted system
1						BOD5 75 400/ and 56 45 0/	anpianioa system.
1	1			1	1	DODD - / J.49 /0 alla J0.43 %	1

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		[				1	
						PO4-83.51% and 64.45%, NO3- 88.48 % and 61.80 %	
13	Xiaoyun Fu ,Xingyuan He	Monochoriakorsakowii And Alismaplantagoaquatica	Water bucket	-	5 days	TN- 94.9% and77.0%	M. korsakowiihad a higher capability to remove nutrients from
		sagittifolia					wastewater.
14	Ramprasad	PharamitesAustrails	SSF	Gravel	1 day	BOD-90%	Pollutant removal
				and		Nitrogen -63%	efficiency is good in
15	Carls an durantes a	T11	HCCE	Sand	1 .1	COD 5(410/450.150/	Truch a latifation when the
15	Marwan et al	rypnaratiiona,saccharu	пээг	Gravel	1 day	BOD-37 31% and 56 72%	more effective than
	Wiai wali et al	mspontaneum		Glaver		TSS-97 96% and 88 83%	saccharumspontaneum
						saccharumspontaneum and	plant in cleanup
						Typhalatifolia	technology.
						BOD-95.89%	Eichhorniacrassipes
	Yadav S. B. et al	EichhorniaCrassipes				COD-97%	reduce organic matter
16		_	VFCW	-	1 day	TSS-82%	efficiently from
						Phosphate-50%	wastewater
						TSS 41%	soil layers filtration
17		D1		G 1 1		TDS 76%	might have more
1/	G. Baskar, V.I.	PhragmitesAustralis	HF and VF	Sand and	-	IP //%,	effected
	Deeptha			Gravel	~	BOD 75%	for BOD and COD
			N 1 1 1	101	. h	COD -54 9%	TyphaLotifolia was
	Gauang sun et al.	PharagmiteAustarils.			1	NH4–N -54.8%	better in campare to
18	0	TyphaLotifolia and		Sand and	3,4,5	TN - 90% .	PharagmiteAustarils
		AcorusCalamus	HSSF	Gravel	days		,AcorusCalamus plants.
19	C.A Prochaska et al.	PharagmitesAustrails	VSSF	Gravel	3	COD -96%	Not required to increase
					days	PO4 – P – 52%	in depth from 0.6cm to
						<u>IN - 60%</u>	lm.
						Removal rate of $SS_000/020/7NI_859/$	Sixth day of UDT
						88% Phosphate-85% -90% in	shows higher removal
					6.3.	6davs.	efficiency.
	Suntudsirianuntapib-	TyphaLotifolia	VSSF	Sand and	and	SS- 87%-91%, TN- 68%-	5
20	oon	And		Gravel	1.5	72%,Phosphate 77%-81% in	
		Canna Sieamensis		-	days	3days.	
		$\langle 0 \rangle$				SS- 84%-87%, TN- 56%-63%	
						,Phosphate -52%-63% in	
		$\langle 0 \rangle \langle t \rangle$		~		The removal rate for nitrogen	VF system support
		PhragmitesAustrails	VSSF and	Gravel	/	nitrogen ammonia .nitrate	nitrification and HF to
	Keffala C, Gharabi A.	and	HSSF	and		nitrogen of 27%,19%,4% for	denitrification in
21		TyphaLotifolia		sand	/	planted, 5%,6%,13% for	nitrogen removal
<u> </u>					~ (	unplanted	
			llin	1.	17.	In the first year removal rate of	Pollutant removal
			111	31.	4	phragmitesaustrails and	efficiency is good in Phragmitas Australia
					/	BOD -71%-86% and 76% -	than Typhalotifolia
						81%	than ryphatotiona.
						COD- 64% -78% and 69%-	
		PharagmiteAustrails	HFW			76%	
22	M.L.Solano et al	and	and VFW	Sand and	1.5	TSS 88%-87% and 90%	
		TyphaLotifolia		Gravel	and 3	In second year BOD- 70 %-	
					days	80% and $64%$ - $70%$	
						COD-51%-77% and $05%-87%$	
						83%	
<u> </u>						Removed 99% of bacterial	A well-designed
	Jos T.A. Verhoeven,		Surface-			pollution, 80-90% of COD and	wetland system is
	F.M. Meuleman	PhragmitesAustralis,	flow			BOD and 30–40% of N and P	capable of
23		Typha	wetland	Soil	5 day		furtherimproving the
			Infiltration				effluent quality
			wetland			In the 2.06 days DOD 64.50/	regarding nutrients
						COD- 68%	of HRT had given better
						SS- 79.7%, TP- 21%	cleanup efficiency
						. ,	

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24	Erkankalipci	pharagmiteAustrails	HSSF	Coarse Aggregat e	3.96, 4.56 and 5.4 days	TN- 20.7 In the 4.56days BOD- 65.1%, COD-70.8%, SS- 81.8% TP - 22.7%, TN- 21.9% In the 5.4 days BOD- 71.2% COD- 75.1%	
25	V Luederitz et al	Reed	VSSF	Sand and		SS - 87.3% TP- 24.8%, TN- 23.5% Removal rate of COD -99.5% TN -93.8%	More than 90% of organic load and of total
				gravel	-		N and P removed by HF and VF.

of

References

#### 7. Advantages and Disadvantages Phytoremediation

researchers in finding the better removal efficiency from kitchen wastewater in phytoremediation with different HRT.

#### 7.1 Advantages of phytoremediation

- Phytoremediation is economical as compare to other treatment methods.
- It is a natural process not harmful to the environment.
- It is effective on low strength contaminants.
- It is very easy method to operate.
- It is more effective method for removal of hazardous pollutants.
- It is effective for removing dissolved nutrients.

#### 7.2 Disadvantagesof phytoremediation

- It is required large area for installation.
- Highly toxic materials can effect on aquatic plant.
- When the high concentrated pollutants present in wastewater than Pretreatment processes is necessary.
- Repeated cleaning processes is necessary
- The type of plants are also affects the phytoremediation process.
- Depth of plant root is affects the potential of plant for uptake
- Climatic conditions is also affected the Performance of phytoremediation technology

## 8. Conclusion

In this paper we focused on phytoremediation method for treating waste water. From the above study the use of plants for removing of contaminants from waste water is cost effective and having a very less operation and maintenance work. The phytoremediation mechanism has high removal rate of pollutants along with different HRT. In this paper we also focused on the aquatic plants and their pollutant removal efficiency. This study shows that plants gives good result in cold climatic condition. The removal of the contaminants is dependent on the type planted beds. Canna plant is a good option for plantation in the development of wetlands because it is easy to grow in any local climatic condition and more decontamination efficiency. In this papers observed that the HRT is directly proportional to the effectiveness of phytoremediation system .The treatment also improved the physical characteristics of the kitchen wastewater such as colour and turbidity. The treated water use for gardening and other related purposes. We hope this paper would help

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